Seasonal Trends of Particulate Matter: Selected Western Cities 2010-2015

J. Harnden, Sunridge Middle School, Pendleton, Oregon
NASA LaRC Mentor M. Pippin

Background

Particulate matter measurements for selected western cities are primarily dependent on topography and seasonal weather patterns, along with land use and population. Similar topography yields similar statistics regarding particulate matter data. All of the observed cities are located in basins, however elevation varies. Resulting weather patterns frequently include wintertime inversions. Particulate matter sources may vary by season: agricultural dust in summer and fall, smoke in summer and fall, and smoke and other fine pollutant materials in winter. Weather patterns in the spring including wind and precipitation reduce particulate matter concentrations. Winter periods consistently show higher particulate measurements in all locations. Summer spikes are the result of regional fires and smoke.

Conclusions

Increases and decreases in particulate matter measurements do not demonstrate consistent patterns of change over the past five years, regardless of the population base or land use. Slight increases or decreases are observed, however the lack of consistency requires more investigation to determine the basis for the changes. Possible contributing factors may be changes in local regulations and ordinances, population increases or decreases, related industrial modifications, or significant variations in local weather.

Resources

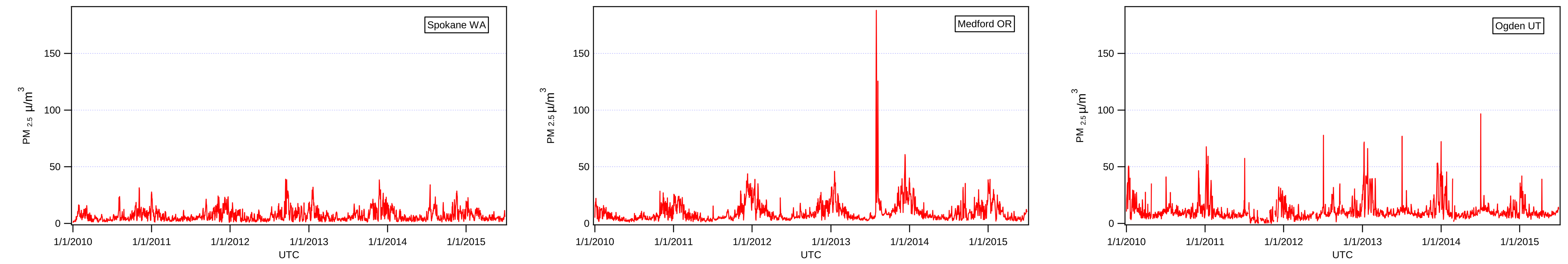
Moulding, B.D, Bybee, R.W., & Paulson, N. (2015). A Vision and Plan for Science Teaching and Learning: An Educator's Guide to A Framework for K-12 Science Education, Next Generation Science Standards, and State Science Standards. Salt Lake City, UT: Essential Teaching and Learning Publications.
ametsoc.edu/dstreme
airnow.gov
airnowtech.org
ncdc.noaa.gov/
noaa.gov
Oregon Department of Education
wrh.noaa.gov/pdt/
worldaffairsmonthly.com/images/contactus/westernunitedstates.jpg

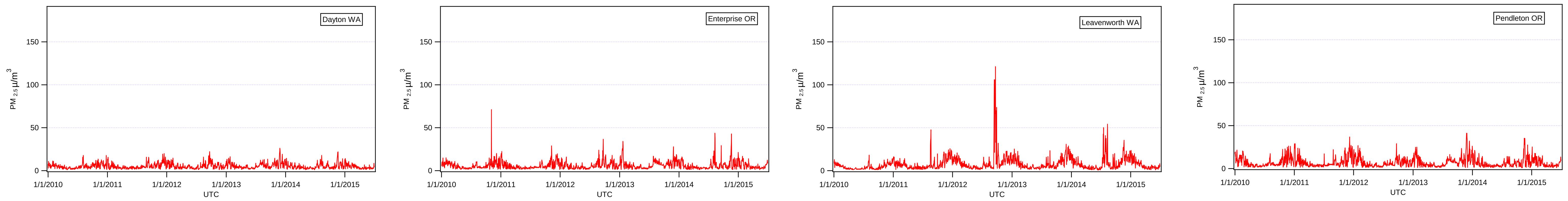
Acknowledgements

Engagement in Authentic Research with NASA (LEARN) project with funding provided to a NASA SMD EPOESS grant. The NASA Langley LEARN Project facilitated access and analysis of air quality observations including $PM_{2.5}$, and weather observation data. Grade-level appropriate related activities were conducted at Sunridge Middle School. NGSS materials were obtained from publications (see references) and the Oregon Department of Education.

$PM_{2.5}$ Data 2010-2015

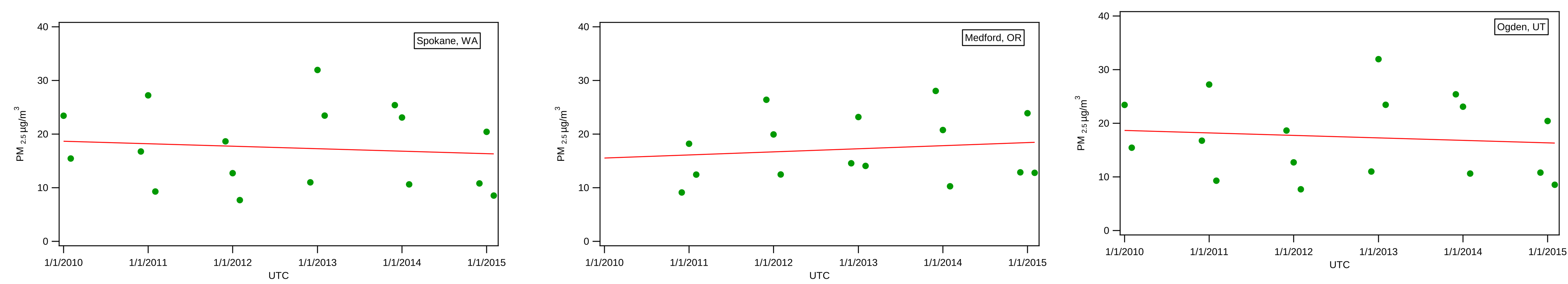
Average, daily particulate matter measurements are plotted for January 2010-June 2015. Winter averages are consistently higher than summer averages, with the exception of summer fires. Dayton, WA an agricultural area, shows the lowest measurements. Ogden, UT shows the highest $PM_{2.5}$ measurements.

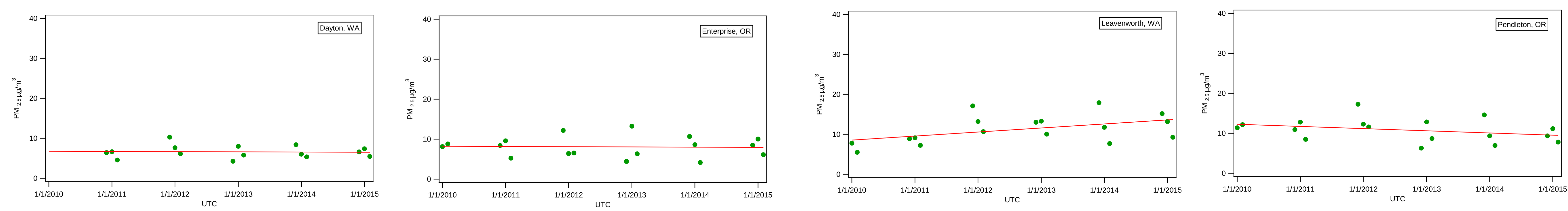




Winter Particulate Matter Measurements Averaged by Month

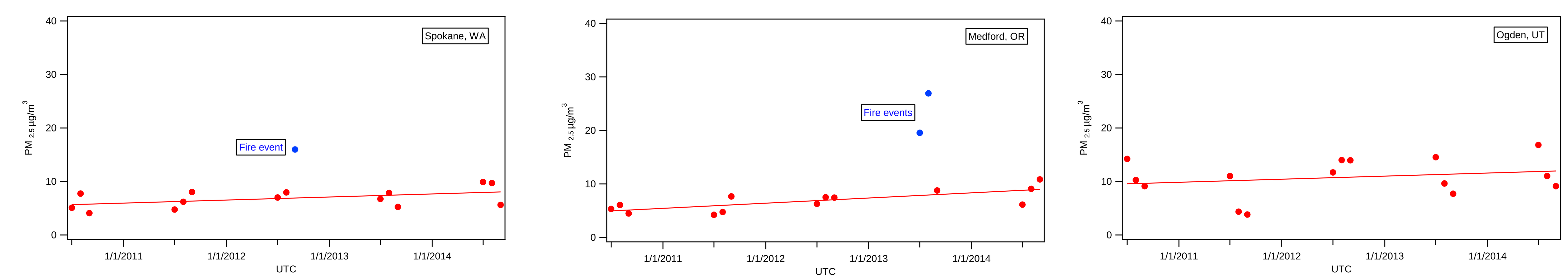
Winter measurements of particulate matter show no consistent trend patterns of substantial increase or decrease. For all locations averages are higher for winter than summer, regardless of the trend. Locations of higher population density maintain consistently higher particulate matter measurements (Spokane, Medford, Ogden).

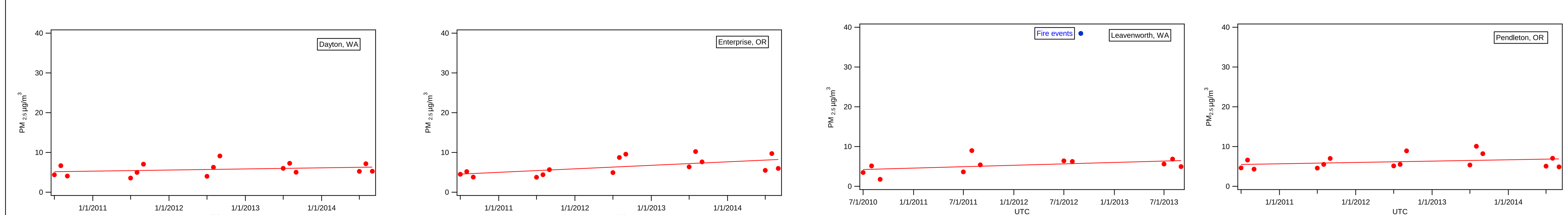




Summer Particulate Matter Measurements Averaged by Month

Summer measurements of particulate matter have shown little to no increase when hourly data from July, August, and September are averaged for 2010-2014. Spikes attributable to fires are not included in the trend lines, however the blue points represent the average when this data is included in calculations.



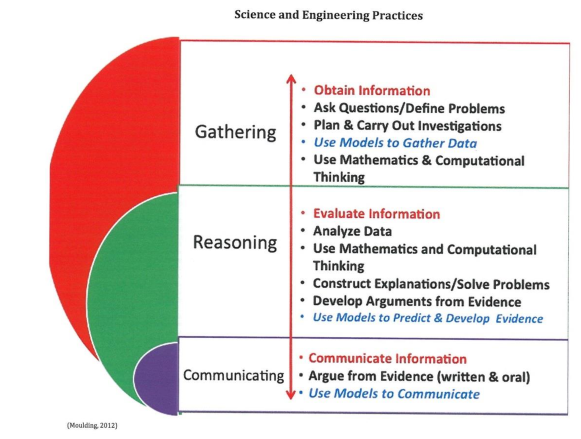


Classroom Connections

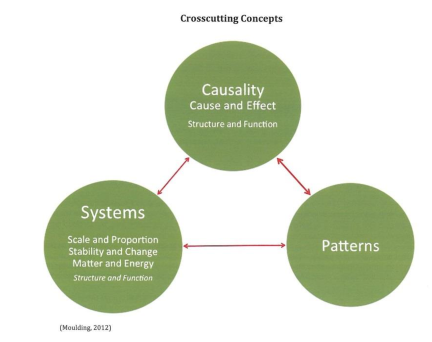
Translating LEARN into classroom practice

Science instructional standards have been adopted by all US states. Some have adopted Next Generation Science Standards as written or with slight modifications while many additional states have written standards that are very similar. The processes used by teachers participating in the LEARN program have modeled the same processes students use when participating in instruction designed to follow NGSS.

NGSS-based instruction is built upon science and engineering practices, disciplinary core ideas, and crosscutting concepts. Performance expectations are based upon supporting practices, ideas, and concepts. Students are engaged in the process of science, not just the content. Connecting ideas and evidence are integral.



Throughout the LEARN project teachers have engaged in the same processes students will under NGSS classroom practice. Working with NASA scientists and collecting data for analysis on questions that develop over time model the processes students will undertake. Puzzling through the data, searching for explanations and sharing the results for peer review are sometimes difficult for teachers who are unfamiliar with the process. LEARN has provided an opportunity to explore the application of the same skills students will be required to develop.



A specific example is the performance expectation HS-ESS3-6 which states: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. Related science and engineering practices include analyzing and interpreting data. Natural hazards, weather and climate, and natural resources are connecting disciplinary core ideas. Crosscutting concepts of cause and effect, systems and system models, and stability and change can all be developed under a study regarding air quality or atmospheric change studies. By participating in LEARN teachers have the opportunity to be students and generate a more thorough understanding of science and science processes.